Moving magnetic features in the periphery of sunspots

The proposed coordinated observations aim at understanding the intrinsic nature of moving magnetic features (MMFs) in the periphery of sunspots, trying to discriminate a few possibilities on their origin: 1) They are a part of magnetic flux of sunspots and representing sunspot decay; 2) They are propagating kinks or knots in the magnetic lines of force of sunspots; 3) They are manifestations of some type of flux emergence in sunspot outer edges; 4) They are submerged magnetic flux caused by mass loading or dragged by convection. We plan the joint observations with BBSO/NST, Hinode and IRIS. Our proposal to NST has been already accepted and arranged in the interval of August 25-31.

Sunspots with/without well-developed moat and located close to the disk center will be chosen. Infrared spectro-magnetograph observations and spectral images at photosphere and chromosphere will be taken with NST; Vector magnetic fields of MMFs will be obtained for the first time with NST infrared Stokes-polarimetry and Hinode SOT/SP. Hinode observations are decisive in accurate determination of vector magnetic field of MMFs and relevant plasma ejection and heating

Intimately connected with the penumbra and the sunspot moat are the so-called MMFs, small magnetic elements that move radially outward across the moat until they either disappear or reach the surrounding photospheric network. The feature was first described by Sheeley (1969) as moving bright points in CN band images, and later well studied by Harvey & Harvey (1973). MMFs have a range of lifetime of 1-8 hours (Vrabec 1974; Zhang et al. 2003; Hagenaar & Shine 2005), and move with a speed typically around 1 km/s. Their average size is 1.7 Mm^2 (Hagenaar & Shine 2005). MMFs are thought to be carried away from a sunspot by plasma flows (Vrabec 1971; Lee 1992). Shine & Title (2001) have proposed a classification to categorize the MMFs into three types. Type I MMFs are bipolar pairs of magnetic elements, and the separation between two polarities is in the range of 1100-1700 km. Type II MMFs are single magnetic elements of the same polarity as the parent sunspot, they provide the primary mechanism for the decay of a sunspot. Type III MMFs are also single magnetic elements but with polarity opposite to that of the sunspot and move at higher speeds than the other two. Without vector field measurements, the classification becomes obscure in getting clear picture of their magnetic topology。

The magnetic and spectroscopic measurements with high spatial resolution obtained by NST, together with the accurately-calibrated vector field measurements from Hinode SOT/SP, would provide a chance to discriminate the real magnetic nature of MMFs, thus to help with understanding their origin. We attempt to locate the first appearance of MMFs by using the magnetograph observations and confirm their Doppler velocity according to the spectral records of Hα; In addition, the manifestation of MMFs in the photosphere, chromosphere and transition region will be studied, and a three dimensional view will be reconstructed then. The magnetic flux changes of the parent sunspot and the enhanced network outside the moat in the course of MMFs' appearance will be accurately determined. Based on these quantitative results, we can obtain a better physical picture of MMFs.

1) Request to SOT

16:00-20:00 UT, repeat SP IQUV scans (fast map, FOV 20"X80", 0.32" slit, 4 min cadence) during the coordinated observation.

20:00-23:00 UT, large FOV SP IQUV scans (Normal map, FOV 80”X80”, 0.16”, 40 min cadence) during the coordinated observation.

2) Request to XRT

   Ti/Poly images, FOV completely covers the SOT/SP FOV, 1” resolution, cadence 1 min or higher.

   G-band image is needed for alignment purpose, but the exposure is very low cadence

3) Request to EIS

   Observing the same target region as SOT/SP, to measure Doppler velocity and material horizontal flow

Other participating instruments

BBSO/NST

IRIS

Remarks

a) Dates:

   BBSO/NST has granted Aug. 25-31 for this observing proposal.

b) Time Windows:

   17:00-23:00 UT. (the good seeing at BBSO in this period)

c) Target of interest:

   A mature sunspot near solar disk center will be the target, and the sunspot apparently is surrounded at least partially by moat. By comparison, one or two young and developing sunspot locating solar disk center could be selected for one or two day observation.